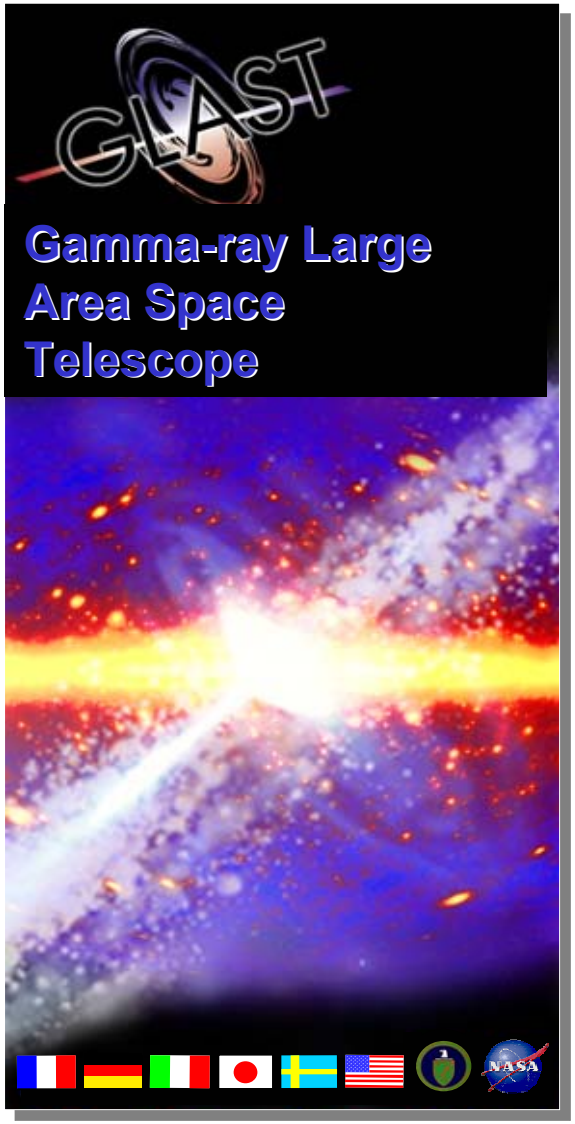

GLAST Large Area Telescope:

LAT System Engineering

Dick Horn
SLAC
System Engineering Manager

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408 771-3550

Topics

- Action Item Status
- Technical Baseline Management
- Requirements Management
- Verification Planning
- Interface Control Documentation
- RFA Closure
- Key Metrics
- Risk Management

Monthly Action Item Status

Action Item ID	Actionee	Description	Status
7-30-03-001	Jim Martin/R.Johnson	GSFC is moving toward de-orbit decision – Assumes split tungsten foils: Need LAT impact assessment if implemented	**OPEN:** Assessment Completed. Minimum impact expected, coupon test evaluation and analysis identified. GSFC reviewing Tabbed foil approach. ECD:15 September.
7-30-03-002	Dick Horn/Whipple	GSFC is moving toward ROM from SAI to conduct LAT environmental test. Ensure GSFC has sufficent data for quote.	**CLOSED:** Horn/Whipple coordinated on requirements.
7-30-03-003	Graf/Virmanti/Haller	Schedule a review of ACD parts plan. Resolve residual GSFC management concern.	**CLOSED:** Parts process review with GSFC. GSFC confirmed approach.
7-30-03-004	Campell/Bielawski	Mechanical Subsystem to determine if we can complete harness tie down details with ACD prior to 29 August.	**CLOSED:** Insufficent ACD/LAT Mockup to complete by 29 August, ECD:15 September.
7-30-03-005	Haller	Produce a specific list of ESGE versions & capabilies planned for each identified need & timeframe.	**OPEN:** ECD 27 August
7-30-03-006	Haller	For TEM/TEM PS to be provided to CAL Qual/Accept program; provides a specific list of differences from flight (hardware/software/performance), include any constraints for use (T/V, EMC…..)	**OPEN:** ECD 27 August
7-30-03-007	Haller	Provide current software schedule to Project Office, include specific time frame where integrated EM1 S/W in integrated configuration (all modules w/ planned capability)	**OPEN:** ECD 27 August
7-30-03-008	Jerry Clinton	Define and maintain the production readiness/execution plan to include vendor selection and associated schedule to ensure unit availability dates are met	**OPEN**: Draft production plan completed & provided to GSFC. Refinement required as vendors are selected. ECD:17 December.
7-30-03-009	Dick Horn	Establish subsystem metrics to ensure critical design elements are closing (e.g. drawings) and fabrication issues are monitored for closure and adverse trends (e.g. NCRs), phase in as possible	**OPEN**: Initial drawings and process status in place. Power & mass updates in work, ECD: 24 September. Planning for NCR tracking in work ECD: 15 December.

Technical Baseline

- Systems Engineering has begun a series of efforts to ensure that the Technical Baseline is understood and under adequate control
- Focus for this month has been on the Flight Drawing Tree
  - Initiated a bottoms up review of the drawing tree
    - Highlighted the need for tool and process improvements (see next page)
    - Updating drawing tree to correct errors detected during the audit
  - Identified list of intermediate assembly drawings
    - These drawings show how the LAT subsystems are installed
    - Added to Drawing Tree

Tool Development

- **Configuration Management database moving from CyberDOCS to Oracle**
  - **CyberDOCS had limitations that prevented sufficient control over the Technical Baseline**
    - **Some documents not yet in CyberDOCS because the input process is cumbersome or because CyberDOCS cannot hold all the required document types**
  - **A replacement Oracle database has been generated, is being refined, and is expected to be on-line by mid September**
  - **Will use opportunity to improve process and educate team**
    - **Updating Configuration Management Plan to increase detail on the drawing release process**
    - **Briefing planned to coincide with Oracle data base roll out to reinforce the release process**
    - **Creating a drawing checker checklist**
- **Providing intermediate Excel tools**
  - **Tracks SLAC drawing status based on CyberDOCS status**
  - **Provides additional reports (such as where used) to support audit of the drawing tree**

CyberDOCS Drawing Metrics

Drawing Status				
Subsystem	**Total**	**Planned**	**In Progress**	**Complete**
Anticoincidence Detector	100	24	12	64
Tracker	88	13	32	43
Calorimeter	131	16	15	100
Mechanical	43	9	23	11
Radiator				
Data Acquisition	145	57	88	0
Integration	5	5		
Instrument Total	512	124	170	218
		24%	33%	43%

'Complete' indicates passed initial SE audit, many 'In Progress' are available in Cyberdocs

Materials and Processes

GLAST LAT Materials & Parts List

Total List

	Inorganic	Polymer & Composite	Lubricant	Process	Total
ACD	36	47	1	13	97
Calorimeter	21	32	0	6	59
Electronics	6	12	2	4	24
Mechanical	78	26	4	11	119
I&T	0	0	0	0	0
Tracker	24	35	2	3	64
Total	165	152	9	37	**363**
Accepted by LAT	163	138	9	37	347
Approved by GSFC	163	138	9	37	347

Requirements Traceability & Verification Planning

Requirements Traceability and Verification

- **Continuous tracking of requirements changes (Monthly Status)**
  - **There were no new CCB-approved changes to level 2 and 3 technical requirements to be incorporated into the DOORS verification matrix**
- **Verification Working Group**
  - **Provided inputs to Norman Rioux for the System Verification Plan, effort still in process**
- **Expand current verification matrix to include interface requirements**
  - **Requirements from the ICDs will be added to the DOORS verification matrix (ECD 9/25/03)**

Requirements & Performance Verification Progress

Test Data Requirements

- Prepared set of data requirements to cover EM/Pathfinder test activities

- **Test Performance**
  - Coordinating planning & implementation of program EGSE – S.E. actively and aggressively supporting this issue. Will have the LAT level plan for review at Sept. meeting
  - Developing LAT comprehensive performance tests
    - based upon
      - Subsystem performance tests
      - Science recommendations.
    - Working group being established to formulate tests to be performed that support instrument requirements and performance verification.

Test Activity Summary

Calorimeter EM

- Conducted data review against End Item Data Package Requirements
- Reproduced Results in B-33 – *a success*
- Reviewing Calorimeter "Users Manual" for Test components applicable to LAT level testing

Tracker Mini-Tower

- Conducted Pre-Ship review against End Item Data Package Requirements (EM /Pathfinder version)
- Reproducing TKR test results in B-33 (*in-process)*
- Applying Tracker "Users Manual" for Test components applicable to LAT level testing

Calorimeter Test performance Matrix (sample)

Script	Test description		Comprehensive Functional Testing AFEE & TEM Elex	Limited Functional Testing AFEE & TEM Elex	Cosmic Muon Test		
CALU_init	Reinitialize calorimeter		•	•			
CALF_EXR_P01	Exercise registers		•	•			
CALU_COLLECT_MUONS	Run muon checkout for optical bond failures		•	•			
CALU_PEDESTALS_CI	Compute pedestals		•	•			
CALF_GAIN_P01	Calibrate electronic gains with charge injection		•	•			
CALF_SHP_P01	Calibrate slow shaper and determine optimal charge-injection Tack time delay under Timed Readout		•	•			
CALF_SHP_P02	Calibrate slow shaper and determine optimal charge-injection Tack time delay under Self-Triggered Readout		•				
CALU_COLLECT_CI_SINGLEX16	Charge injection collection on one channel on each of 16 rows		•				
CALU_COLLECT_CI	Charge injection collection on one channel on each of 16 rows		•				
CALF_ADC_P02	Analysis of charge injection calibration data to determine integral non-linearity and noise		•				
CALF_TRG_P01	Test CAL-LO and CAL-HI trigger enable/disable with charge injection		•				
CALF_TRG_P03	Characterize FLE and FHE DAC settings with charge injection		•				
CALF_TRG_P04	Characterize FLE and FHE trigger times		•				
CALF_TRG_P05	Determine optimal FLE and FHE DAC settings with charge injection		•				
CALF_SUPP_P01	Calibrate LAC DAC settings with charge injection		•				
CALF_SUPP_P02	Determine optimal LAC DAC settings.		•				
CALF_RNG_P01	Calibrate ULD DAC settings with charge injection		•				
CALT_COLLECT_MUONS	muon checkout; acquire muon data and screen for bond failures				•		

Tracker Test performance Matrix (sample)

TEST	Test #	Product	Aliveness	Limited Performance	Comprehensive Performance
Power					
Power Consumption	TE101	DC Power Consumption	▪	▪	▪
Temperature	TE102		▪	▪	▪
Leakage Curent	TE103		▪	▪	▪
Functional					
GTRC Register Load & Read	TE201		▪	▪	▪
GTFE Register Load & Read	TE202		▪	▪	▪
GTFE Register Load & Read-Bdcst	TE203		▪	▪	▪
Reset- hard &soft	TE204		▪	▪	▪
Read-out sequence & Threshold Control	TE205	Threshhold offset & noise value		▪	▪
Read-out sequence with charge injection	TE206	Dead Channel List		▪	▪
Trigger Peformance	TE401			▪	▪
Performance					
Noise Perfoamence & Threshold Stability	TE301				▪
Trigger Peformance	TE401				▪
Noise Occupancy -idle	TE501				▪
Noise Occupancy -operating	TE502				▪
Efficiency/**R**esolution/**A**lignment	TE503				▪
Trigger/Readout Rate	TE504				▪

Interface Management

Key Open Internal LAT Interface Issues

INTERFACE	KEY OPEN ISSUES	STATUS	RESOLUTION	ECD
Tracker	Validating TKR-Grid copper strap thermal design.	• Detailed design complete. • Testing is underway.	TKR to complete thermal testing as part of Engineering Model test plan closure.	11/30/03
Calorimeter	Validating CAL Base Plate to Grid structural design.	• Pre-Peer Review held with GSFC on 8/15/03. Pre-review went well in general. Areas were identified that require clean-up. • Interior grid stress analysis in process.	• Complete analysis for Gridbox Strength Qualification Test. • Conduct formal review with GSFC.	9/12/03 9/17/03
ACD	None			
Electronics	Validating X-LAT Plate to Electronics box thermal joint design.	• Rigid joint design selected. • Detailed design in process. • Stacked E-box thermal test progress: E-box enclosures on order and detailed test schedule in process.	• Complete Layout drawings of X-LAT plate and heatpipes. • Complete thermal analysis. • Peer review for official closure.	9/5/03 9/19/03 9/26/03

Key Open External LAT Interface Issues

INTERFACE	KEY OPEN ISSUES	STATUS	RESOLUTION	ECD
Spacecraft	Radiator mechanical interface details need to be finalized.	• Face-to-Face meeting held on 7/16/03 and design details were agreed upon.	• Mechanical TIM scheduled for Sept 9th. ICD drawing will be finalized.	9/9/03
		• ICD drawing is in an iteration cycle.	• Update ICD.	9/26/03
Spacecraft	Finalize harness definition and routing.	• Finalizing interface connector pin-outs.	• Mechanical TIM scheduled for Sept 9th. Finalize harness routing and strain relief details.	9/9/03
		• Harness routing and strain relief concepts complete.	• Update ICD.	9/26/03

Interface Documentation Status

Document	Status
LAT-SC Interface Control Document (Spectrum Astro Managed Document)	
1196 EI-Y46311-000	Released 25 Apr 03
1553 Bus Potocol Document	
1196 EI-S46310-000	Released 25 Apr 03
GBM-LAT Interface Control Document	
433-ICD-0001	Second draft in-progress
Calorimeter	
LAT-DS-00233-6: CAL-LAT Interface Definition Drawing	Released 6 May 03
LAT-SS-00238-4: CAL-LAT Mech, Therm, Elec Interface Control Document	Released 13 Mar 03
ACD	
LAT-DS-00309-3: ACD-LAT Interface Definition Drawing	Released 22 Apr 03
LAT-SS-00363-5: ACD-LAT Mech, Therm, Elec Interface Control Document	Released 28 Apr 03
Tracker	
LAT-DS-00851-1: TKR-LAT Interface Definition Drawing	Second draft in-progress
LAT-SS-00138-5: TKR-LAT Mech, Therm Interface Control Document	Released 14 Apr 03
LAT-SS-00176-2: TKR-LAT Elec Interface Control Document	Released 27 Jan 03
Electronics	
LAT-DS-01630-1: Electronics-LAT Interface Definition Drawing	First draft review complete
LAT-SS-01794-1: Elec-LAT Mech, Therm, Elec Interface Control Document	Second draft in-progress
SAS	
LAT-SS-02365-1: SAS-LAT Interface Control Document	First draft in-progress

Summary

- **Participated in LAT-SC ICD Power Review**
  - **Discrepancies were identified and action items assigned**
  - **New revision of ICD to be released in early October**
  - **Mech review scheduled for 9/9/03**
  - **Data and Thermal reviews to be scheduled**
- **CAL Baseplate-Grid Interface**
  - **Pre-peer review was successful**
  - **Wrapping up final action items**
  - **Formal peer review for closure scheduled for 9/17/03**
- **X-LAT Plate-Electronic Box Interface**
  - **Design and analysis schedule is in place**
  - **Tasks are being completed on schedule**
  - **Formal peer review for closure scheduled for 9/26/03**

RFA Closure

- Coordinated plan of attack in place –Horn/Graf/Hascall/Melton
  - LAT baseline response to CDR RFA's – 30 September
  - GSFC/LAT consolidation (murder board review) of peer review RFA's – 22 September (proposed)
  - GSFC PDR/dPDR RFA closure follow-up – Mid October
- Significant progress on key RFA's
  - Electronics manufacturing plan – draft available
  - Cal/Grid closure – closure plan in on track
  - X-LAT Closure – closure plan on track
  - Tracker thermal margins – Design temperature relaxed
  - Mechanical analysis – closure plan on track
- Current status of all RFA's on SE website

Key Design Metrics
(No updates Since CDR)

Update In Progress, Report in Sept

LAT Mass Status

LAT Mass Status Report — LAT-TD-00564-06

LAT Mass Status
Martin Nordby

Effective Date: 7-Mar-03
Print Date: 7-Mar-03

March 2003

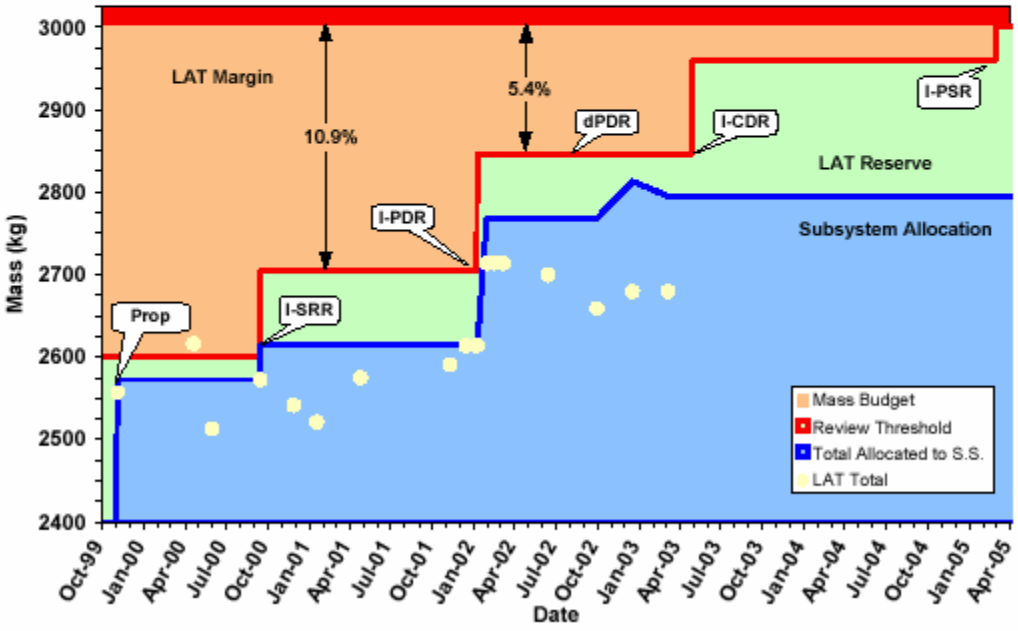
Mass (kg)	Estimate	Alloc.
TKR	504.9	510.0
CAL	1375.8	1440.0
ACD	270.1	280.0
Mech	329.3	345.0
Elec	199.3	220.0
LAT Total	**2679.4**	**2795.0**
Rsrv/Margin	320.6	
Rsrv/Margin*	12.0%	
Allocation		3000.0

* AIAA G-020 recommended min reserve = 7.2%

Mass Estimate Breakdown	(kg)	%
Parametric	382.3	14.3%
Calculated	975.8	36.4%
Measured	1321.3	49.3%
Total	2679.4	100%

Center of Mass (mm)		
CMx	1.26	-20 < CMx < 20
CMy	-0.54	-20 < CMy < 20
CMz	-86.89	CMz < -51.2
Ht off LIP	149.31	Ht < 185

Second Moment of Inertia (kg-m^2)		
Ixx	1057.7	1500.0
Iyy	1014.9	1500.0
Izz	1339.5	2000.0



LAT Power Status

5-Apr-03 Item	Estimate (Watts)	PARA (Watts)	CALC (Watts)	MEAS (Watts)	ALLOC. (Watts)
ACD	9.4	2.3	3.9	3.2	10.5
Tracker	152.4	1.5	0.0	150.9	153.0
Calorimeter	64.9	0.0	0.0	64.9	65.0
Trigger & Data Flow	326.2	211.5	114.7	0.0	327.5
Grid/thermal	20.4	20.4	0.0	0.0	35.0
Instrument Total	573.3	235.7	118.5	219.0	591.0
Instrument Allocation	650.0				
% Reserve	13.4%				

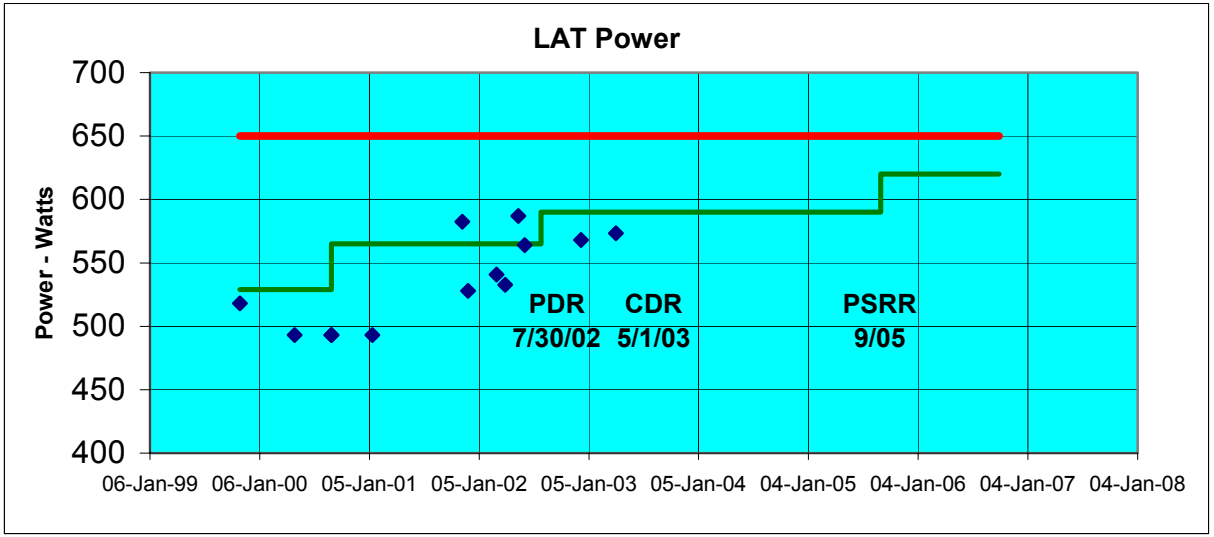
LAT-TD-00125-04

PDR Reserve Was 15.2%

Goal for CDR Reserve > 10%
Goal for PSRR Reserve > 5%

PARA - Best Estimate based on conceptual design parameters
CALC - Estimate based on Calculated power from detailed design documentation
MEAS - Actual power measurements of components

Goals estimated using guidelines given in ANSI/AIAA G-020-1992 "Estimating and Budgeting Weight and Power Contingencies for Space Craft Systems"



FSW Resource Usage Current Estimates

Resource	Total Available	Anticipated Usage	Margin Factor
EPU Boot PROM	256 kB	128 kB	2
SIU Boot PROM	256 kB	128 kB	2
EPU EEPROM	4 MB	1.5 MB	2.7
SIU EEPROM	8 MB	1.5-2.5 MB	3-5
EPU CPU cycles	200% in 2 EPUs	30%	> 6
SIU CPU cycles	100% in 1 SIU	25%	4
EPU memory	128 MB	16-32 MB	4-8
SIU memory	128 MB	< 16 MB	8
Bandwidth – instrument to EPU	20 MB/sec	5 MB/sec	4
Bandwidth – EPU or SIU to SSR	5 MB/sec	40 kB/sec	112
Bandwidth – CPU to CPU	2.5 MB/sec	20 kB/sec	125

LAT-TD-1121-01

Key Science Performance Metrics

Parameter	SRD Value	Present Design Value
Peak Effective Area (in range 1-10 GeV)	>8000 cm^2	10,000 cm^2 at 10 GeV
Energy Resolution 100 MeV on-axis	<10%	9%
Energy Resolution 10 GeV on-axis	<10%	8%
Energy Resolution 10-300 GeV on-axis	<20%	<15%
Energy Resolution 10-300 GeV off-axis (>60°)	<6%	<4.5%
PSF 68% 100 MeV on-axis	<3.5°	3.37° (front), 4.64° (total)
PSF 68% 10 GeV on-axis	<0.15°	0.086° (front), 0.115° (total)
PSF 95/68 ratio	<3	2.1 front, 2.6 back (100 MeV)
PSF 55°/normal ratio	<1.7	1.6
Field of View	>2sr	2.4 sr
Background rejection (E>100 MeV)	<10% diffuse	6% diffuse (adjustable)
Point Source Sensitivity(>100MeV)	<6×10^{-9} $cm^{-2}s^{-1}$	3×10^{-9} $cm^{-2}s^{-1}$
Source Location Determination	<0.5 arcmin	<0.4 arcmin (ignoring BACK info)
GRB localization	<10 arcmin	5 arcmin (ignoring BACK info)

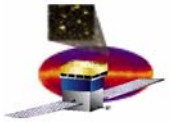
Risk Management

Risk Management Activity

- No Updates From July

Top risks to cost

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
SE--0007	Moderate	Critical component failure post LAT integration requiring de-integration impacting cost & schedule	•Extensive use of EM test bed to support flight H/W & S/W development •Thorough qualification and acceptance tests •Pre planned I&T actions for de-integration	• Completed evaluation for improving access (9/02) • Qual & acceptance planning in-place •I&T developing contingency plans
Proj Mgt - 005	Moderate	Parts and vendor orders have not been completed therefore flight production cost may exceed projection	•Manufacturing engineer added to expedite minimum cost closure •Clarification and purchase package review to ensure accurate bids	• Processes in place •Remaining vendor selections by 11/03
Proj Mgt - 006	Moderate	Critical skilled positions (senior personnel) required to execute project remain open, potential impact to cost and schedule if not closed in short term	•Management team has identified critical skill needs • Identify skilled personnel within Collaboration environment	• Added SLAC Site Rep in Italy • Added Scientist to Tracker Team •Software candidates interviews ongoing •Mechanical candidates interviews ongoing •ECD 10/03



Top risks to schedule

ID #	Risk Rank	Risk Description	Risk Mitigation	Status
Proj Mgt - 003	Moderate	Completion of Tracker subsystem qualification program delayed due to EM closure or MCM electronics	• Manufacturing Eng assigned to close MCM issues • Increased team integration with Italian partners • GSFC audit/support to Tracker EM closure	• Teledyne contracted as MCM vendor • SLAC Site rep added to Italian team
Proj Mgt - 002	Moderate	ASIC's fail to meet requirements; results in schedule impact	•Focused review & test. Margin for re-runs protected where possible •Individual risks Identified by subsystem	• Tracker/DAQ ASIC's flight ready • Cal/ACD ASIC's expected 9/03
Proj Mgt - 004	Moderate	TEM Power supply final design is delayed, final implementation may exceed current schedule	•Key focus item identified for DAQ • Design peer review planned for 9/03 • Basing approach on flight proven designs where possible	• Design closure 9/03
SE-- 0007	Moderate	Critical component failure post LAT integration requiring de-integration impacting cost & schedule	•Extensive use of EM test bed to support flight H/W & S/W development •Thorough qualification and acceptance tests •Pre planned I&T actions for de-integration	• Completed evaluation for improving access (9/02) • Qual & acceptance planning in-place •I&T developing contingency plans

4.1.2 Cost & Schedule Status

- **Cost variance - $217K**
  - **$65K delay in subcontract billing cycle**
  - **$152K expenditures transferred to IOC**
  - **System Engineering expenditures are on plan**

- **Schedule variance – On track/LOE**

3-Month Milestones

- Update the LAT-MD-00408 LATPVP – August -> September
- Support Fault Management TIM - 26 August Kick-off
- Support STOP Analysis TIM's - On going
- Complete FMEA – November (Pending Power Supply Design)
- Add ICD requirements to DOORS – September
- Complete Spacecraft ICD Review - September
- Refine risk program - September
- Close remaining Internal ICD TBX's - October
- Update System Metrics – October (Then Quarterly)
- Hold EM Test & Qualification Readiness Reviews – TBD (Re-plan)
- Close all open RFAs – October->December